09-28-00

+UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	09792909-0425
First Named Inventor or Application Identifier	Yoshinari Matsuda
Express Mail Label No:	EL370089630US

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☒ Specification — Total Pages 32
2. ☒ Drawing(s) (35USC 113) — Total Pages 8
3. ☒ Declaration and Power of Attorney — Total Pages 3
   a. ☒ Unexecuted(original or copy)
   b. ☐ Copy from prior application (37CFR 1.63(d)) *(for continuation/divisional with Box 14 completed)*
   [Note Box 4 Below]
   i. ☐ DELETION OF INVENTOR(S)
   Signed statement attached deleting inventor(s) named in the prior application,see 37 CFR 1.63(d)(2) and 1.33(b).
4. ☐ Incorporation By Reference (usable if Box 3b is checked)
   The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 3b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

ACCOMPANYING APPLICATION PARTS

5. ☐ Assignment Papers (cover sheet & documentation)
6. ☒ Letter under 37 CFR 1.41(c).
7. ☐ English Translation Document *(if applicable)*
8. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
9. ☒ Preliminary Amendment
10. ☒ Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
11. ☐ Small Entity Statement(s) ☐ Statement filed in prior Application, Status still proper and desired
12. ☒ Certified copy of Japanese priority document No. P11-271950 filed September 27, 1999

14. If a CONTINUING APPLICATION, *check appropriate box and supply the requisite information:*

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) ☐ of prior application No:

CLAIMS AS FILED

(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) BASIC FEE $690.00
TOTAL CLAIMS 20	20		18.00	0.00
INDEPENDENT CLAIMS 03	3		78.00	0.00
	ANY MULTIPLE DEPENDENT CLAIMS? ☐ YES ☒ NO			
			TOTAL FEE	$690.00

☒ The Commissioner is hereby authorized to charge any additional fees which may be required in connection with this application, or credit any overpayment to ACCOUNT NO. 19-3140. A duplicate copy of this sheet is enclosed.

☒ A check in the amount of $690.00 to cover the filing fee is enclosed.

15. CORRESPONDENCE ADDRESS: David R. Metzger
SONNENSCHEIN NATH & ROSENTHAL
P.O. Box #061080
Wacker Drive Station, Sears Tower
Chicago, IL 60606-1080
Telephone (312) 876-8000 - Fax (312) 876-7934

SIGNATURE: David R. Metzger DATE: September 27, 2000

U-11 David R. Metzger (No. 32,919)

Sonnenschein
SONNENSCHEIN NATH & ROSENTHAL

David R. Metzger
312/876-2578

8000 Sears Tower
233 South Wacker Drive
Chicago, IL 60606
312.876.8000
312.876.7934 fax
www.sonnenschein.com

Chicago
Kansas City
Los Angeles
New York
San Francisco
St. Louis
Washington, D.C.

September 27, 2000

Assistant Commissioner of Patents
Washington, D.C. 20231

RE: New U.S. Application for Letters Patent entitled
"PRINTED WIRING BOARD AND DISPLAY APPARATUS"
Applicant(s): Yoshinari Matsuda, et al.
Attorney Docket No. 09792909-0425

Dear Sir

Under the provisions of 37 C.F.R. §1.41(c), I am filing the attached application, including 20 claims (3 independent), 8 sheets of drawings (Figs. 1-9D) and $690.00 filing fee on behalf of

YOSHINARI MATSUDA, YOSHIO SUZUKI, RYOTA ODAKE
and NOBUTOSHI ASAI

and request that the application be assigned a serial number and filing date purusant to the provisions of 37 C.F.R. §1.53(b) and 37 C.F.R. §1.53(d).

Very truly yours,

SONNENSCHEIN NATH & ROSENTHAL

By: David R. Metzger

Enclosures

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

PRELIMINARY AMENDMENT ACCOMPANYING APPLICATION

APPLICANT: Yoshinaru Matsuda ATTY. DOCKET NO. 09792909-0425

SERIAL NO.

DATE FILED:

INVENTION: "PRINTED WIRING BOARD AND DISPLAY APPARATUS"

Assistant Commissioner of Patents
Washington, D.C. 20231

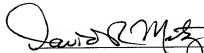
S I R:

Between the title and the heading "Background of the Invention" on page 1, insert the following:

--RELATED APPLICATION DATA

The present application claims priority to Japanese Application No. P11-271950 filed September 27, 1999, which application is incorporated herein by reference to the extent permitted by law.

Respectfully submitted,



(Reg. No. 32,919)

David R. Metzger
SONNENSCHEIN NATH & ROSENTHAL
P.O. Box #061080
Wacker Drive Station
Sears Tower
Chicago, IL 60606-1080
Attorneys for Applicant(s)

PRINTED WIRING BOARD AND DISPLAY APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a printed wiring board including conductive patterns, and a display apparatus including a display device and a drive component for driving the display device.

As one structure of electroluminescence (EL) display apparatus, there has been known a structure wherein a display device is packaged by using a protective glass board, which protects the display device and allows light emitted from the display device to pass therethrough, and a printed wiring board which includes an insulating substrate made from an organic synthetic resin and to which the display device and a drive component therefor are electrically connected.

The EL display apparatus having the above structure is disadvantageous in that since the insulating substrate of the printed wiring board is made from an organic synthetic resin, moisture is easy to permeate the printed wiring board and to reach the EL display device which is generally poor in moisture resistance, with a result that the EL display apparatus is difficult to stably display pictures for a long-period of time.

SUMMAY OF THE INVENTION

An object of the present invention is to provide a printed wiring board allowing circuit parts poor in moisture resistance to be stably operated for a long-period of time, and to provide a display apparatus capable of stably displaying pictures for a long-period of time by using the printed wiring board.

A printed wiring board according to a first invention includes a glass substrate provided with through-holes, and conductive patterns provided on both surfaces of the glass substrate in such a manner as to be made conductive to each other via the through-holes, and accordingly, by electrically connecting circuit parts to be electrically connected to each other to the conductive patterns provided on both the surfaces of the printed wiring board, these circuit parts can be electrically connected to each other without use of any planar special region.

Further, according to the printed wiring board of the first invention, the conductive patterns are formed on both the surfaces of the glass substrate and the through-holes provided in the glass substrate are filled with a sealing member. Accordingly, moisture does not permeate the printed wiring board. As a result, although

the printed wiring board constitutes part of the packages for the circuit parts, moisture does not reach the circuit parts through the printed wiring board.

According to a printed wiring board according to a second invention, the glass substrate on both surfaces of which the conductive patterns are formed is a no-alkali glass substrate. The no-alkali glass contains a very small amount of alkali ions being relatively easy to be migrated. As a result, even when a voltage is applied to the glass substrate via the conductive patterns provided on both the surfaces of the glass substrate, the glass substrate causes less ion migration.

According to a printed wiring board of a third invention, the sealing member provided to fill the through-holes of the glass substrate is a conductive paste containing an epoxy resin as a binder. The epoxy resin has a high sealing performance, and the paste, which is a conductive material, is easy to fill the through-holes. As a result, it is possible to easily carry out works of making the conductive patterns on both the surfaces of the glass substrate conductive to each other and of sealing the through-holes.

According to a printed wiring board of a fourth invention, a conductive film is provided on an inner wall

surface of each of the through-holes in such a manner as to connect the conductive patterns provided on both surfaces of the glass substrate to each other, and an inner space, inside the conductive film, of each through-hole is filled with the sealing member. Since the conductive film having a resistivity lower than that of the paste is formed on the inner wall surface of each through-hole, the conductive patterns on both the surfaces of the glass substrate can be connected to each other with a low resistance.

According to a printed wiring board of a fifth invention, the sealing member provided to fill an inner space, inside the conductive film, of each through-hole formed in the glass substrate is an epoxy resin. Since the epoxy resin has a high sealing performance, the sealing performance at the through-holes of the glass substrate becomes high.

According to a printed wiring board of a sixth invention, the surface of the sealing member exposed from each of the through-holes of the glass substrate is covered with a metal film. As a result, the sealing performance at the through-holes becomes high.

According to a printed wiring board of a seventh invention, each of the conductive patterns has a stacked

structure of a chromium film and a copper film formed thereon. Since chromium has a high adhesiveness to the glass substrate and the copper has a low resistivity, the conductive pattern is less peeled from the glass substrate and becomes low in its resistance.

According to a printed wiring board of an eighth invention, each of the conductive patterns has a stacked structure of an epoxy resin film and a copper film formed thereon. Since the epoxy resin film can be easily formed on the glass substrate and copper has a low resistivity, each conductive pattern having a low resistance can be simply formed.

A display apparatus according to a ninth invention includes a printed wiring board having a glass substrate provided with through-holes, and conductive patterns provided on both surfaces of the glass substrate in such a manner as to be made conductive to each other via the through-holes; a display device provided on one surface of the printed wiring board in such a manner as to be connected to the conductive pattern provided on the one surface of the printed wiring board; and a drive component, for driving the display device, disposed on the other surface of the printed wiring board in such a manner as to be connected to the conductive pattern

provided on the other surface of the printed wiring board. With this configuration, since the display device and the drive component therefor provided on both sides of the printed wiring board are electrically connected to each other via the through-holes, it is possible to eliminate the need of providing any region specialized for electrically connecting the display device to the drive component therefor. Further, since the display device and the drive component therefor are integrated with the printed wiring board, it is possible to reduce the total thickness of the display device, the drive component therefor, and the printed wiring board.

Further, according to the display apparatus of the ninth invention, the display device is provided on the one surface of the printed wiring board, the protective glass board is provided in such a manner as to face to the one surface of the printed wiring board, and a second sealing member is provided to surround the display device while being in contact with the printed wiring board and the protective glass board. These printed wiring board, protective glass board, and second sealing member constitute a package for the display device.

Of the parts constituting the package, the protective glass board and the second sealing member do

not allow the permeation of moisture therethrough. On the other hand, the conductive patterns are provided on both surfaces of the glass substrate of the printed wiring board and the through-holes provided in the glass substrate are filled with a first sealing member. As a result, moisture is not allowed to permeate the printed wiring board and to reach the display device.

A display apparatus according to a tenth invention includes a printed wiring board having a glass substrate provided with through-holes and conductive patterns provided on both surfaces of the glass substrate in such a manner as to be made conductive to each other via the through-holes, a display device connected to the conductor pattern provided on one surface of the printed wiring board via bumps, and a drive component, for driving the display device, connected to the conductor pattern provided on the other surface of the printed wiring board. Accordingly, it is possible to eliminate the need of providing a planar region specialized for electrically connecting the display device and the drive component therefor on both the sides of the printed wiring board to each other. Further, since the display device is connected to the conductive pattern on one surface of the printed wiring board via the bumps, and

the drive component for driving the display device is connected to the conductive pattern on the other surface of the printed wiring board, it is possible to reduce the total thickness of the display device, drive component therefor, and printed wiring board.

Further, according to the display apparatus of the tenth invention, a protective glass board is provided in such a manner as to face to the one surface of the printed wiring board, a display device is provided on the surface, facing to the printed wiring board, of the protective glass board, and a second sealing member is provided to surround the display device while being in contact with the printed wiring board and the protective glass board. These printed wiring board, protective glass board, and second sealing member constitute a package for the display device.

Of the parts constituting the package, the protective glass board and the second sealing member do not allow the permeation of moisture therethrough. On the other hand, the conductive patterns are provided on both surfaces of the glass substrate of the printed wiring board and the through-holes provided in the glass substrate are filled with a first sealing member. As a result, moisture is not allowed to permeate the printed

wiring board and to reach the display device.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partial sectional side view of an EL display apparatus according to a first embodiment of the present invention;

Fig. 2 is a plan view of a printed wiring board according to the first embodiment;

Fig. 3 is a plan view of a plurality of the printed wiring boards according to the first embodiment, which are flatly stuck to each other;

Figs. 4A to 4D are partial sectional side views showing, in sequence, initial steps of fabricating the EL display apparatus according to the first embodiment;

Figs. 5A to 5C are partial sectional side views showing, in sequence, intermediate steps of fabricating the EL display apparatus according to the first embodiment;

Figs. 6A to 6C are partial sectional side views showing, in sequence, final steps of fabricating the EL display apparatus according to the first embodiment;

Fig. 7 is a partial sectional side view of an EL display apparatus according to a second embodiment of the present invention;

Figs. 8A to 8C are partial sectional side views showing, in sequence, the first half steps of fabricating the EL display apparatus according to the second embodiment; and

Figs. 9A to 9D are partial sectional side views showing, in sequence, the second half steps of fabricating the EL display apparatus according to the second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, first and second embodiments in each of which the present invention is applied to a simple matrix type EL display apparatus and a printed wiring board used therefor will be described with reference to Figs. 1 to 9D.

A method of fabricating a printed wiring board and an EL display apparatus according to the first embodiment will be described with reference to Figs. 1 to 6C. As shown in Fig. 4A, a glass substrate 11 of 1.1 mm in thickness made from a no-alkali glass is prepared, and through-holes 13 are formed in the glass substrate 11 at positions corresponding to those of anode electrodes and cathode electrodes necessary for a simple matrix type EL display apparatus by turning a diamond drill 12 or

turning the diamond drill 12 while imparting ultrasonic waves to the diamond drill 12.

The diamond drill 12 is formed by electrodepositing fine particles of diamond on the surface of an ultra-high hardness steel containing typically Cr, Mo, W, Mn, Ni, and Ti, or sintering a mixture of a powder of the ultra-high hardness steel and fine particles of diamond. The frequency and energy of ultrasonic waves are set at about 20 kHz and 500 W, respectively. The turning of the diamond drill 12 with ultrasonic waves imparted to the diamond drill 12 allows the formation of the through-holes 13 with inner wall surfaces desirably finished for a short-time. As shown in Fig. 4B, the through-holes 13 may be formed by covering the surface of the glass substrate 11 with a mask 14 except for areas at which the through-holes 13 are to be formed, and subjecting the glass substrate 11 partially covered with the mask 14 to sand blasting.

As shown in Fig. 4C, a silver paste 15 containing an epoxy resin as a binder is printed on the glass substrate 11, to fill the through-holes 13 with the silver paste 15. The silver paste 15 is then thermally hardened, and on each side of the glass substrate 11, an excess of the silver paste 15 on the surface of the glass

substrate 11 is mechanically polished until the surfaces of the silver paste 15 portions in the through-holes 13 become the same level as that of the surface of the glass substrate 11. Then, as shown in Fig. 4D, a chromium film 16 and a copper film 17 each of which has a thickness of 0.3 μm or less are sequentially vapor-deposited overall on each surface of the glass substrate 11 including the surfaces of the silver paste 15 portions exposed from the through-holes 13. The chromium film 16 is formed for enhancing the adhesiveness between the glass substrate 11 and a conductive pattern, and the copper film 17 is formed for reducing the resistance of the conductive pattern.

As shown in Fig. 5A, on each side of the glass substrate 11, a resist 21 is formed on the stack of the chromium film 16 and the copper film 17 except for areas at which a conductive pattern is to be formed, and a nickel film 22 and a gold film 23 each of which has a thickness of 0.3 μm or less are sequentially vapor-deposited. The nickel film 22 is formed for facilitating the vapor-depositing of the gold film 23. The gold film 23 is formed for preventing oxidation of the surface of the copper film 17 thereby facilitating the soldering of circuit parts to a conductive pattern. Then, as shown in

Fig. 5B, the resist 21 is removed, to thereby lift-off the nickel film 22 and the gold film 23 except for the areas at which a conductive pattern is to be formed.

As shown in Fig. 5C, the copper film 17 and the chromium film 16 are partially removed by etching using the remaining portion of the gold film 23 as a mask. In this way, conductive patterns 24 each being composed of the chromium film 16, copper film 17, nickel film 22, and gold film 23 are provided on both the surfaces of the glass substrate 11 in such a manner as to be made conductive to each other via the silver paste 15 portions in the through-holes 13, to thus form a printed wiring board 25.

As shown in Fig. 6A, an insulating film 26 typically made from silicon oxide is vapor-deposited on one surface of the glass substrate 11, and openings 27 are formed in the insulating film 26 at connection portions between the conductive pattern 24 and anode electrodes and cathode electrodes. An aluminum film is vapor-deposited on the insulating film 26 and the like, and is patterned typically in the row direction to form cathode electrodes 31. Then, as shown in Fig. 6B, an EL light emitting layer 32 including an organic or inorganic light emitting layer, an electron transfer layer, and the

like is vapor-deposited and is patterned to remain at display pixels which are intersections between the cathode electrodes 31 and anode electrodes.

As shown in Fig. 6C, an insulating film 33 is vapor-deposited on the EL light emitting layer 32 and the like, and openings 34 are formed in the insulating film 33 at connection portions between the conductive pattern 24 and the EL light emitting layer 32 and anode electrodes. A transparent ITO (Indium Tin Oxide) film is vapor-deposited on the insulating film 33 and the like, and is pattern typically in the row direction to form anode electrodes 35. It should be noted that the ITO film may be replaced with an IXO film in which tin is replaced with another element insofar as the IXO film can form the transparent anode electrodes 35.

As shown in Fig. 1, an epoxy resin 36 is applied to the peripheral portion of the surface, on the EL light emitting layer 32 side, of the printed wiring board 25, and a protective glass board 37 is stuck on the printed wiring board 25 via the epoxy resin 36. Then, a drive component (not shown) for driving the EL light emitting layer 32 is soldered to the conductive pattern 24 formed on the surface, opposite to the EL light emitting layer 32, of the printed wiring board 25. According to an EL

display apparatus thus fabricated, since the EL light emitting layer 32 and the drive component therefor are integrated with the printed wiring board 25, it is possible to reduce the total thickness of the EL light emitting layer 32, the drive component therefor, and the printed wiring board 25, and hence to make thin the entire EL display apparatus.

Further, in this EL display apparatus, the EL light emitting layer 32 provided on one surface of the printed wiring board 25 is electrically connected to the drive component provided on the other surface of the printed wiring board 25, so that as shown in Fig. 2, a planar region specialized for electrically connecting the EL light emitting layer 32 to the drive component therefor is not required. Accordingly, as shown in Fig. 3, by flatly sticking a plurality of the printed wiring boards 25 to each other, it is possible to uniformly, flatly arrange the EL light emitting layers 32, and hence to display a large-sized picture without any cut line.

A method of fabricating a printed wiring board and an EL display apparatus according to the second embodiment of the present invention will be described with reference to Figs. 7 to 9D.

First, as shown in Fig. 8A, a glass substrate 41 of

1.1 mm in thickness made from a no-alkali glass is prepared. Epoxy resin films with copper foils are press-bonded on both surfaces of the glass substrate 41 by using hot rolls 42. In this way, an epoxy resin film 43 of 40 μm in thickness and a copper foil 44 of 18 μm in thickness provided thereon are formed overall on each surface of the glass substrate 41. Then, as shown in Fig. 8B, portions of the copper foils 44, located at positions where through-holes corresponding to anode electrodes and cathode electrodes necessary for a simple matrix type EL display apparatus are to be formed, are removed by etching, or the surfaces of the copper foils 44 are overall removed by etching.

As shown in Fig. 8C, like the fabrication step in the first embodiment shown in Fig. 4A, through-holes 46 corresponding to the anode electrodes and cathode electrodes necessary for the simple matrix type EL display apparatus are formed in the glass substrate 41 by using a diamond drill 45. Upon formation of the through-holes 46, since at least the portions of the copper foils 44 located at the positions where the through-holes 46 are to be formed have been already removed as described above, particles of copper softer than glass do not clog spaces among fine particles of diamond of the diamond

drill 45. This is effective to eliminate inconveniences caused by clogging of the diamond drill 45 with copper particles, and more specifically, prevent degradation of the drilling performance of the diamond drill 45, breakage of the diamond drill 45, and cracking of the glass substrate 41.

As shown in Fig. 9A, thin copper electroless plating and thick copper electroplating are sequentially performed on the glass substrate 41, to form a copper film 47 having a thickness of 20 to 30 μm overall on both the surfaces of the glass substrate 41 including the inner wall surfaces of the through-holes 46. It should be noted that even if the surfaces of the copper foils 44 are overall removed by etching before the formation of the through-holes 46 as described above, since the copper film 47 is formed overall on both the surfaces of the glass substrate 41, it is possible not only to form conductive patterns with no problem but also to simplify the fabrication steps by eliminating the need of forming masks for partially covering the copper foils.

Since the epoxy resin film 43 is interposed between the stack of the copper foil 44 and the copper film 47 and the glass substrate 41, a force of 9.8 N or more is required to be applied for peeling the stack (width: 1

cm) of the copper foil 44 and the copper film 47 from the glass substrate 41. That is to say, it is possible to obtain a practically sufficient adhesive strength between the stack of the copper foil 44 and the copper film 47 and the glass substrate 41. Then, as shown in Fig. 9B, an inner space, inside the copper film 47, of each of the through-holes 46 is filled with an epoxy resin 51, followed by thermal hardening of the epoxy resin 51, and an excess of the epoxy resin 51 on both the surfaces of the glass substrate 41 is mechanically polished until the upper surfaces of the epoxy resin 51 portions in the through-holes 46 become the same level as that of the copper film 47.

As shown in Fig. 9C, copper electroless plating and copper electroplating are sequentially performed on the glass substrate 41, to form a copper film 52 having a thickness of 5 to 20 μm overall on both the surfaces of the glass substrate 41 including the upper surfaces of the epoxy resin 51 portions exposed from the through-holes 46. Then, as shown in Fig. 9D, on each side of the glass substrate 41, the stack of the copper films 52 and 47 and the copper foil 44, except for portions at which a conductive pattern is to be formed, is removed by etching, to thereby form a conductive pattern 53 composed of the

stack of the copper foil 44 and the copper films 47 and 52. In this way, a printed wiring board 54, in which the conductive patterns 53 on both the surfaces of the glass substrate 41 are made conductive to each other via the copper film 47 in the through-holes 46, is formed.

As shown in Fig. 7, conductive bumps 55 made from a metal are formed on one surface of the printed wiring board 54. On the other hand, an ITO film or the like is vapor-deposited on one surface of a protective glass board 56 made from a no-alkali glass, and is patterned typically in the row direction to form anode electrodes 57. An organic or inorganic EL light emitting layer 61 is vapor-deposited on the anode-electrodes 57 and the like, and is patterned to remain at display pixels which are intersections between the anode electrodes 57 and cathode electrodes.

An insulating film 62 is vapor-deposited on the EL light emitting layer 61 and the like, and openings 63 are formed in the insulating film 62 at connection portions between the anode electrodes 57 and the bumps 55 and connection portions between the EL light emitting layer 61 and cathode electrodes. An aluminum film is vapor-deposited on the insulating film 62 and the like, and is patterned typically in the column direction to form

cathode electrodes 64. An adhesive bond layer 65 is formed on the protective glass board 56. The adhesive bond layer 65 is made from a resin which is thermally plasticized at a relatively low temperature, for example, polyester, polyvinyl chloride, polyvinyl acetate, polyamide, or polyurethane.

The anode electrodes 57 and the cathode electrodes 64 are positioned to the corresponding bumps 55. The adhesive bond layer 65 is heated up to its softening temperature, and in such a state, the bumps 55 are press-bonded to the anode electrodes 57 and the cathode electrodes 64. Then, the adhesive bond layer 65 is cooled to be thus hardened. As a result, the anode electrodes 57 and the cathode electrodes 64 are electrically connected to the corresponding bumps 55, and simultaneously the printed wiring board 54 is stuck on the protective glass board 56.

An epoxy resin 66 is applied to respective peripheral portions of the printed wiring board 54 and the protective glass board 56. A drive component (not shown) for driving the EL light emitting layer 61 is soldered to the conductive pattern 53 formed on the surface, opposite to the bumps 55, of the printed wiring board 54. An EL display apparatus according to the second

embodiment is thus fabricated. Like the EL display apparatus according to the first embodiment, the EL display apparatus according to this embodiment does not require any planar region specialized for electrically connecting the EL light emitting layer 61 to the drive component therefore. Accordingly, it is possible to uniformly, flatly arrange the EL light emitting layer 61 by flatly sticking a plurality of the printed wiring boards 54 to each other and also flatly sticking the protective glass boards 56 to each other, and hence to display a large-sized picture without any cut line.

In this EL display apparatus in which the printed wiring board 54 is stuck on the protective glass board 56 via the adhesive bond layer 65, since the linear expansion coefficient of the glass substrate 41 of the printed wiring board 54 is equal to that of the protective glass board 56, it is possible to prevent the reliability of the sticking plane from being lowered due to the thermal expansion/contraction. Further, since the glass substrate 41 of the printed wiring board 54 is not required to be baked at a high temperature unlike a ceramic substrate, the glass substrate does not suffer from dimensional change and warping due to baking at a high temperature and can be easily stuck on the

protective glass board.

By the way, in the first embodiment, the EL light emitting layer 32 is formed on the printed wiring board 25 having the through-holes 13 filled with the silver paste 15, and in the second embodiment, the bumps 55 are formed but the EL light emitting layer 61 is not formed on the printed wiring board 54 having the through-holes 46 on the inner wall surfaces of which the copper film 47 is formed. However, in the first embodiment, bumps may be formed but the EL light emitting layer be not formed on the printed wiring board 25 having the through-holes 13 filled with the silver paste 15, and in the second embodiment, the EL light emitting layer 32 may be formed on the printed wiring board 54 having the through-holes 46 on the inner wall surfaces of which the copper film 47 is formed.

The glass substrate 11 of the printed wiring board 25 in the first embodiment and the glass substrate 41 of the printed wiring board 54 in the second embodiment are each made from a no-alkali glass which has a desirable property, that is, a high insulation performance; however, the substrate 11 and 41 are each not necessarily made from a no-alkali glass.

The through-holes 13 of the printed wiring board 25

in the first embodiment are filled with the silver paste 15 containing an epoxy resin as a binder, and the through-holes 46 of the printed wiring board 54 in the second embodiment are filled with the epoxy resin 51; however, the through-holes 13 may be filled with a conductive paste other than the silver paste 15 containing a sealing material other than the epoxy resin as a binder, and the through-holes 46 may be filled with a sealing material other than the epoxy resin 51.

In each of the first and second embodiments, the present invention is applied to the simple matrix type EL display apparatus and the printed wiring board used therefor; however, the present invention can be applied to an EL display apparatus other than the simple matrix type and a printed wiring board used therefor, and also to a display apparatus other than the EL display apparatus, for example, a liquid crystal display apparatus or plasma display apparatus and a printed wiring board used therefor.

In the printed wiring board according to the first invention, by electrically connecting circuit parts to be electrically connected to each other to the conductive patterns provided on both the surfaces of the printed wiring board, it is possible to electrically connect

these circuit parts to each other without use of any planar specialized region, and hence to uniformly, flatly arrange a plurality of desired circuit parts by flatly sticking a plurality of printed wiring boards to each other. Further, since moisture is not allowed to permeate the printed wiring board and reach the circuit parts although the printed wiring board constitutes part of the package for the circuit parts, the circuit parts poor in moisture resistance can be stably operated for a long-period of time.

In the printed wiring board according to the second invention, even when a voltage is applied to the glass substrate via the conductive patterns on both the surfaces of the glass substrate, the glass substrate being less susceptible to ion migration causes less insulation failure. As a result, it is possible to enhance the reliability of the printed wiring board.

In the printed wiring board according to the third invention, it is possible to easily carry out the works of making the conductive patterns on both the surfaces of the glass substrate conductive to each other and of sealing the through-holes, and hence to reduce the fabrication cost.

In the printed wiring board according to the fourth

invention, it is possible to connect the conductive patterns on both the surfaces of the glass substrate to each other with a low resistance, and hence to operate the circuit parts electrically connected to the conductive patterns at a high speed and a low power consumption.

In the printed wiring board according to each of the fifth and sixth inventions, it is possible to enhance the sealing performance at the through-holes of the glass substrate, and hence to stably operate the circuit parts poor in moisture resistance for a long-period of time.

In the printed wiring board according to the seventh invention, since the conductive patterns are less peeled from the glass substrate, the reliability can be enhanced. Further, since the resistance of each conductive pattern is low, it is possible to operate the circuit parts electrically connected to the conductive patterns at a high speed and a low power consumption.

In the printed wiring board according to the eighth invention, since each conductive pattern having a low resistance can be simply formed, it is possible to reduce the fabrication cost. Further, since the resistance of each conductive pattern is low, it is possible to operate the circuit parts electrically connected to the

conductive patterns at a high speed and a low power consumption.

In the display apparatus according to each of the ninth and tenth inventions, it is possible to eliminate the need of providing any region specialized for electrically connecting the display device to the drive component therefore. Accordingly, by flatly sticking a plurality of the printed wiring boards to each other, it is possible to display a large-sized picture without any cut line. Also, it is possible to reduce the total thickness of the display device, drive component therefor, and printed wiring board, and hence to make thin the entire EL display apparatus. Further, since moisture does not reach the display device, even if the moisture resistance of the display device is low, it is possible to stably display a picture for a long-period of time.

While the preferred embodiments of the present invention have been described using the specific terms, such description is for illustrative purposes only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following claims.

What is Claimed is:

1. A printed wiring board comprising:

a glass substrate provided with through-holes;

conductive patterns provided on both surfaces of said glass substrate in such a manner as to be made conductive to each other via said through-holes; and

a sealing member provided to fill said through-holes.

2. A printed wiring board according to claim 1, wherein said glass substrate is a no-alkali glass substrate.

3. A printed wiring board according to claim 1, wherein said sealing member is a conductive paste containing an epoxy resin as a binder.

4. A printed wiring board according to claim 1, wherein a conductive film is provided on an inner wall surface of each of said through-holes in such a manner as to connect said conductive patterns provided on both surfaces of said glass substrate to each other, and

an inner space, inside said conductive film, of said through-hole is filled with said sealing member.

5. A printed wiring board according to claim 4, wherein said sealing member is an epoxy resin.

6. A printed wiring board according to claim 4,

wherein the surface of said sealing member exposed from each of said through-holes is covered with a metal film.

7. A printed wiring board according to claim 1, wherein each of said conductive patterns has a stacked structure of a chromium film and a copper film formed thereon.

8. A printed wiring board according to claim 1, wherein each of said conductive patterns has a stacked structure of an epoxy resin film and a copper film formed thereon.

9. A display apparatus comprising:

a printed wiring board including a glass substrate provided with through-holes, conductive patterns provided on both surfaces of said glass substrate in such a manner as to be made conductive to each other via said through-holes, and a first sealing member provided to fill said through-holes;

a display device provided on one surface of said printed wiring board in such a manner as to be connected to said conductive pattern provided on said one surface of said printed wiring board;

a drive component for driving said display device, said drive component being disposed on the other surface of said printed wiring board in such a manner as to be

connected to said conductive pattern provided on said other surface of said printed wiring board;

a protective glass board disposed in such a manner as to face to said one surface of said printed wiring board; and

a second sealing member provided in such a manner as to surround said display device while being in contact with said printed wiring board and said protective glass board.

10. A display apparatus according to claim 9, wherein said glass substrate is a no-alkali glass substrate.

11. A display apparatus according to claim 9, wherein said first sealing member is a conductive paste containing an epoxy resin as a binder.

12. A display apparatus according to claim 9, wherein a conductive film is provided on an inner wall surface of each of said through-holes in such a manner as to connect said conductive patterns provided on both surfaces of said glass substrate to each other, and

an inner space, inside said conductive film, of said through-hole is filled with said first sealing member.

13. A display apparatus according to claim 12,

wherein said first sealing member is an epoxy resin.

14. A display apparatus according to claim 12, wherein the surface of said first sealing member exposed from each of said through-holes is covered with a metal film.

15. A display apparatus comprising:

a printed wiring board including a glass substrate provided with through-holes, conductive patterns provided on both surfaces of said glass substrate in such a manner as to be made conductive to each other via said through-holes, and a first sealing member provided to fill said through-holes;

bumps provided on said conductive pattern provided on one surface of said printed wiring board;

a protective glass board disposed in such a manner as to face to said one surface of said printed wiring board;

a display device provided on the surface, facing to said printed wiring board, of said protective glass board in such a manner as to be connected to said bumps;

a drive component for driving said display device, said drive component being disposed on the other surface of said printed wiring board in such a manner as to be connected to said conductive pattern provided on said

other surface of said printed wiring board; and

a second sealing member provided in such a manner as to surround said display device while being in contact with said printed wiring board and said protective glass board.

16. A display apparatus according to claim 15, wherein said glass substrate is a no-alkali glass substrate.

17. A display apparatus according to claim 15, wherein said first sealing member is a conductive paste containing an epoxy resin as a binder.

18. A display apparatus according to claim 15, wherein a conductive film is provided on an inner wall surface of each of said through-holes in such a manner as to connect said conductive patterns provided on both surfaces of said glass substrate to each other, and an inner space, inside said conductive film, of said through-hole is filled with said first sealing member.

19. A display apparatus according to claim 18, wherein said first sealing member is an epoxy resin.

20. A display apparatus according to claim 18, wherein the surface of said first sealing member exposed from each of said through-holes is covered with a metal film.

ABSTRACT OF THE DISCLOSURE

A printed wiring board includes a glass substrate provided with through-holes, conductive patterns provided on both surfaces of said glass substrate in such a manner as to be made conductive to each other via said through-holes, and a sealing member composed of a silver paste containing an epoxy resin as a binder provided to fill said through-holes. This printed wiring board is advantageous in that circuit parts can be connected to each other without use of any planar special region and moisture does not reach the circuit parts through the printed wiring board. A display apparatus capable of stably displaying pictures for a long-period of time is provided by using the printed wiring board.

FIG. 1

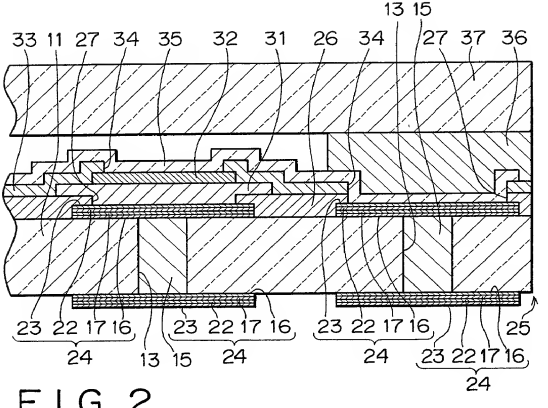
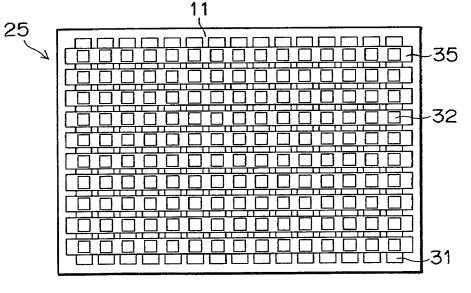

13 15
33 11 27 34 35 32 31 26 34 27 37 36
23 22 17 16
24
13 15
23 22 17 16
24
23 22 17 16
24
23 22 17 16
24
25

FIG. 2


11
25
35
32
31

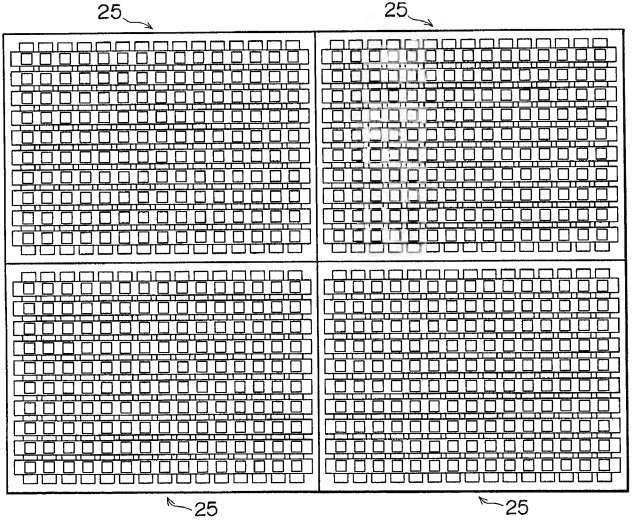


FIG. 3

FIG.4A

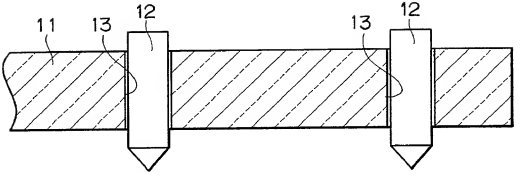


FIG.4B

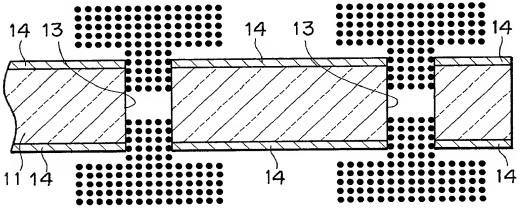


FIG.4C

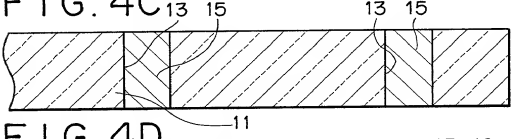


FIG.4D

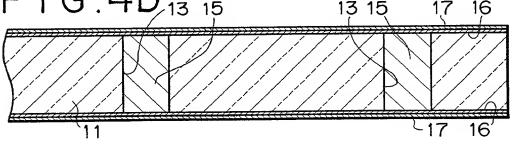


FIG.5A

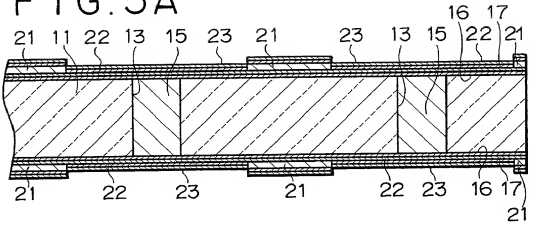


FIG.5B

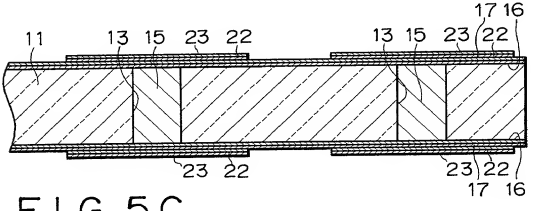


FIG.5C

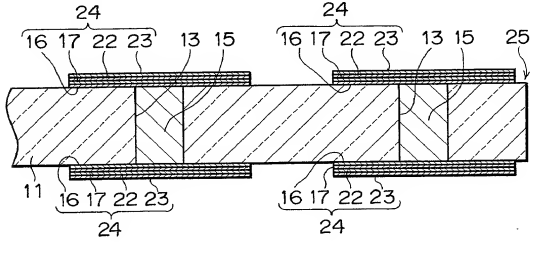


FIG.6A

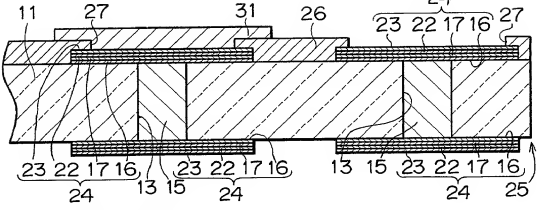


FIG.6B

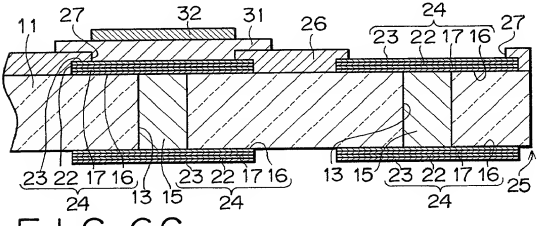


FIG.6C

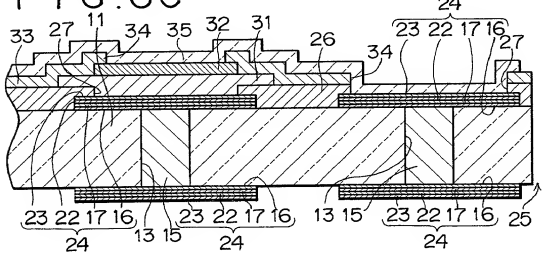


FIG. 7

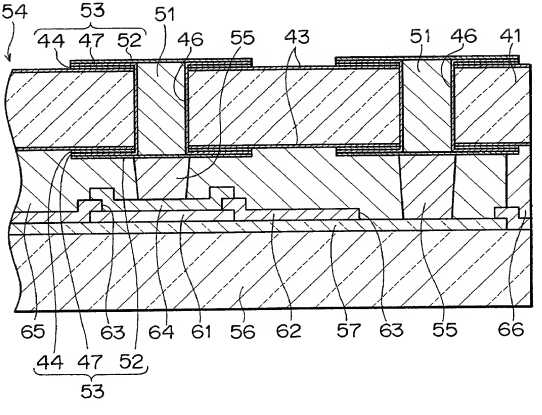

54
53
44 47 52
51
46
55
43
51
46
41
65
44 47 52
53
63
64
61
56
62
57
63
55
66

FIG.8A

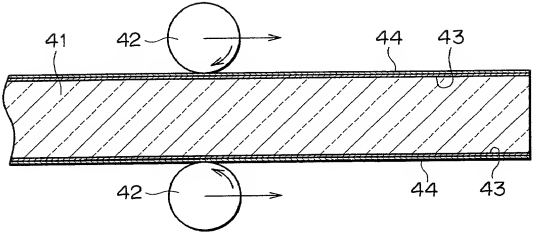


FIG.8B

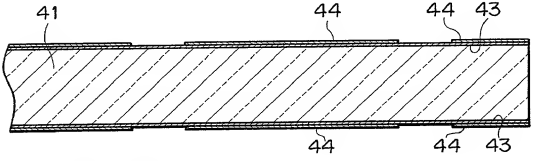


FIG.8C

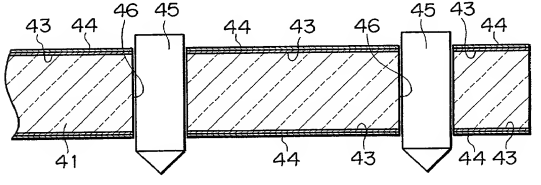


FIG.9A

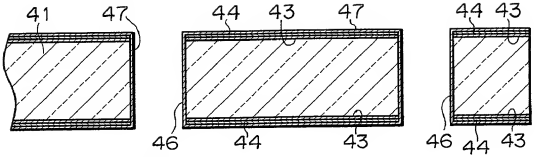


FIG.9B

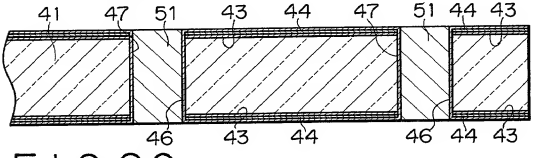


FIG.9C

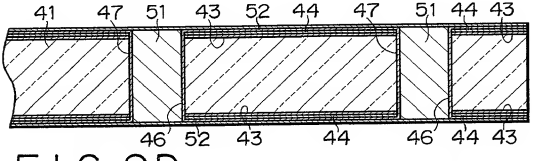
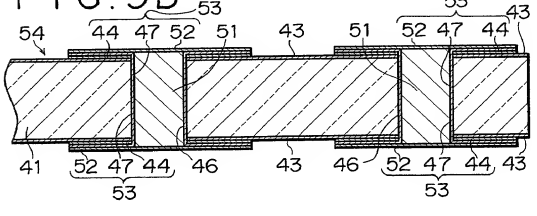


FIG.9D



DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

"PRINTED WIRING BOARD AND DISPLAY APPARATUS"

Case No, **09792909-0425** the specification of which

(check one)
- X is attached hereto
- ____ was filed on _____, as Application Serial No. _____, and was amended on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent Office all information which is known to me to be material to the patentability of this application in accordance with Title 37, Code of Federal Regulations. 1.56[1]

I do not know and do not believe this invention was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and I believe that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as identified below:

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below:

Prior Foreign Application(s) Number	Country	Date
JP11-271950	**Japan**	**September 27, 1999**

and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the above listed application on which priority is claims:

---

[1] (b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a *primafacie* case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the application takes in:

(i) opposing an argument of unpatentability relied on by the Office, or

(ii) asserting an argument of patentability.

A *prima facie* case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden of proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

Prior Foreign Application(s)
Number Country Date

If no priority is claimed, I have identified all foreign patent applications filed prior to this application:
Prior Foreign Application(s)
Number Country Date

And I hereby appoint Joseph A. Mahoney (Reg. No. 38,956), Howard B. Rockman (Reg. No. 22,190), Jordan A. Sigale, (Reg. No. 39,028), Michael A. Molano (Reg. No. 39,777), Michael L. Kiklis (Reg. No. 38,939), Janelle D. Strode (Reg. No. 34,738), Kevin W. Guynn (Reg. No. 29,972), David R. Metzger (Reg. No. 32,919), Jennifer Hammond (Reg. No. 41,814), Lana Knedlik (Reg. No. 42,748), John F. Griffith (Reg. No. 44,137), Marina Saito (Reg. No. 42,121), Alison P. Schwartz (Reg. No. 43,863), Christopher P. Rauch (Reg. No. 45,034), Francisco Rubio-Campos (Reg. No. 45,358), Brian J. Gill (Reg. No. 46,727) and Shashank S. Upadbye, all members of the firm of Sonnenschein, Nath & Rosenthal

Telephone 312/876-0200 Ext. 2578

my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and direct that all correspondence be forwarded to:

SONNENSCHEIN NATH & ROSENTHAL
80th Floor – Sears Tower
233 S. Wacker Drive, Chicago, IL 60606

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor **YOSHINARI MATSUDA**

Inventor's signature _____ Date _____
Residence Kanagawa, Japan
Citizenship Japan
Post Office Address c/o Sony Corporation, 7-35, Kitashinagawa 6-chome
Shinagawa-ku, Tokyo 141, Japan

Full name of second inventor **YOSHIO SUZUKI**

Inventor's signature _____ Date _____
Residence Kanagawa, Japan
Citizenship Japan
Post Office Address c/o Sony Corporation, 7-35, Kitashinagawa 6-chome
Shinagawa-ku, Tokyo 141, Japan

Full name of third inventor **RYOTA ODAKE**

Inventor's signature _____ Date _____
Residence Tokyo, Japan
Citizenship Japan
Post Office Address c/o Sony Corporation, 7-35, Kitashinagawa 6-chome
Shinagawa-ku, Tokyo 141, Japan

Full name of fourth inventor **NOBUTOSHI ASAI**

Inventor's signature _____ Date _____

Residence Kanagawa, Japan

Citizenship Japan

Post Office Address c/o Sony Corporation, 7-35, Kitashinagawa 6-chome
Shinagawa-ku, Tokyo 141, Japan